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AUTHOR	McCord, Joan
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ABSTRACT

The effects of the rapid introduction of computing in education on Drexel University faculty were studied. The university decided that incoming 1983 freshmen would be required to own microcomputers, which could be bought at reduced cost. A questionnaire was administered to determine faculty members' experience with computers, their values, educational background, teaching styles, and views about possible changes that might result from the decision. Responses from 328 full-time faculty indicated that their attitudes toward the university's microcomputing decision depended on the interaction between their academic rank and computer competence. Full professors, regardless of their computer competence, tended to favor the decision. Associate professors who were computer competent were more pleased with the decision than those above or below them in rank, while assistant professors who were not computer competent were less pleased than those above or below them in rank. Except in liberal arts, younger faculty were most likely to have used computers. For engineers, knowledge of computing seemed tied with their continuing education. Among natural scientists, computing seemed more closely allied with having varied interests (in music and visual arts). Faculty participation in computer training was also assessed. (SW)

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A Faculty-Computer Nexus

Joan McCord
Department of Psychology and Sociology
Drexel University

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Director, Microcomputing Program, Drexel University
32nd and Chestnut Streets, Philadelphia, PA 19104
(215) 895-2293

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Joan McCord
Department of Psychology and Sociology
Drexel University

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A FACULTY-COMPUTER NEXUS

The rapid spread of computer utilization can be readily demonstrated by comparing listings of computer services in the yellow pages of 1980 with those for 1984, or by inspecting newspapers for computer advertising over the last couple of years. What is less easily discerned are the psychological and social changes concommitant with the proliferation of computing.

Social change has clearly been responsive to such technological innovations as telephones and televisions. The availability of small, powerful, relatively inexpensive computers seems likely to produce changes of at least as large proportions. One can anticipate greater flexibility regarding place and time for work as well as changes in the work itself. If shopping can be performed by computer, if menus can be modified by giving instructions to a computer, or if education can take place at home as fruitfully as at school, computers can be expected to influence the division of labor as well as the use of time.

Telephones and television could be used without special knowledge. In contrast, at least until recently, computers required technical knowledge to put them to use for anything other than playing games. That technical knowledge becomes particularly interesting when its acquisition does not follow conventional status lines.

Bruner (1983) referred to the educational system as "the sole agent of evolution." His argument rests on a belief that power emerges from a person's ability to manipulate instruments (which he calls "hardware" and "software"). This ability, Bruner argued, is passed from one generation to the next through the educational system.

Whether or not Bruner was right about the unique position of educational institutions, he identified an important focus for understanding social changes. The educational system is both a repository for existing knowledge and a seedbed for innovation. Tension between these functions can be expected to exaggerate stress between the old and the new.

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A university community is an excellent setting in which to study effects of computer proliferation. The several disciplines represented there can be expected to reveal a broad perspective on cultural change.

A university has a clear status structure based on a presumption that the hierarchy reflects differences in relevant abilities. Yet many current professors obtained their graduate educations at a time when computers, if considered at all, were perceived as tools for technicians. Thus graduate education left these older professors poorly prepared for the sudden incorporation of "computer literacy" into lists of basic competencies.

Most universities depend on rational authority (Weber 1921/1947) for the establishment of order. The possibility for a shift in criteria for judging competency can therefore be expected to produce stress in the status structure. Until most members of the faculty are knowledgeable about computing, the introduction of computers to a university should, following Weber, tend to undermine the legitimacy of authority as represented by professorial ranks.

To understand the social impact of a rapid shift in importance of knowing how to use computers, faculty at one university were asked to participate in what will become a five year study of change. The present analysis reports on initial stages of that study. This analysis aims at providing answers to two questions: 1) How do members of a university faculty respond to potential threats to the established status hierarchy? and 2) What types of faculty are most likely to take the lead in technological change?

Background

Drexel University provided an opportunity to study effects of the rapid introduction of computing in education. A faculty committee report dated April, 1982, cited faculty ignorance about computers as a major problem.

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Six months later, Drexel' s President announced that incoming freshmen of the following year would be required to own microcomputers. With this announcement, the previous focus of faculty committees on how to encourage faculty to learn about computers changed to a focus on criteria for selecting an appropriate machine. In early 1983, Drexel signed a contract enabling freshmen and faculty to buy the chosen microcomputer (Apple Macintosh) at reduced cost.

One month after announcement of the contract, a questionnaire was distributed to the faculty. In addition to requesting information about experience with computers, the questionnaire elicited information about values, educational histories, teaching styles, and views about possible changes that might result from the microcomputer decision. Thus, the questionnaire provided "baseline" data that would depict the faculty at the brink of change.

Responses came from 328 (92.9%) of the full-time faculty. Eighteen of the respondents taught physical education. The remaining 310 respondents (from an academic faculty numbering 335) came from academic disciplines: 76 taught in the College of Engineering; 77 taught in the College of Science; 55 taught in the College of Business and Administration; and 102 were spread amongst three liberal arts colleges (Humanities and Social Sciences; the School of Information Sciences; and Nesbitt College of Nutrition, Design, and Human Development).

Results

The questionnaire asked how much experience the respondent had in using computers for teaching, research, or consulting, and whether the respondent had experience with each of several classes of machines (ranging from minicomputers to supercomputers).

To test for effects of the technological revolution on the authority structure, members of the faculty were classified as computer-competent or not. If they reported having considerable experience with at least one

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class of machine, with using computers in teaching, or with using computers for research or consulting, they were considered computer-competent. Slightly more than half the faculty (52.9%) was classified as computer-competent by this criterion: 56.9% of the Full Professors, 44.7% of the Associate Professors, and 56.2% of the Assistant Professors.

The questionnaire asked faculty to note how they felt about the decision to require freshmen to purchase microcomputers. Alternatives being "upset," "worried," or "neutral," those who answered "relatively pleased" or "delighted" constituted 68.4% of the faculty.

If an emphasis on computing was affecting the authority structure, one would expect to find that rank and computing competence would have interaction effects on faculty attitudes toward the new policy.

Table 1 shows the proportion of faculty, by rank and computer-competence, who were pleased or delighted with the decision.

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Table 1

Computing Competence and Decision Satisfaction*
(% Pleased with the Decision)

Rank	Not Computer-Competent	Computer-Competent
Full Professor	(N=48) 66.7	(N=63) 71.4
Associate Professor	(N=52) 51.9	(N=42) 81.0
Assistant Professor	(N=46) 78.3	(N=59) 64.4

SOURCE	DF	CHI-SQUARE	PROB.
Intercept	1	41.46	.0001
Rank	2	0.32	.8522
Competence	1	1.36	.2441
Rank*Competence	2	9.78	.0075

*Academic faculty only

Log-linear analysis (SAS, 1982) shows that neither rank nor computer-competence alone provided an explanation for faculty response to the new computer emphasis. The interaction, however, displayed a significant effect.

Among faculty who were computer-competent, Associate Professors were most likely to be satisfied with the decision to require computing by freshmen. On the other hand, among faculty who had little experience using computers, Associate Professors were least likely to be satisfied with the decision. That is, faculty most likely to gain status through their knowledge were most pleased and, conversely, those who had the most to lose by a shift in criteria for evaluation were least pleased.

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The Full Professors who had been using computers were only slightly more likely to be pleased than those who had not. And among Assistant Professors, those who had computing experience were slightly less likely to be pleased than those who had no experience computing.

The difference in attitude toward the computer decision suggests that faculty at different ranks perceive the impact differently. Full Professors, at the top of the hierarchy, could not improve their formal status. New criteria for promotion would have little impact on them. Assistant Professors, at the bottom of the hierarchy, would already expect to acquire relevant competencies in order to climb the status ladder.

If resistance to an emphasis on computing is partially determined by perceived effects on status, one would expect to find that faculty response to opportunities to prepare for the change would differ by rank.

Members of the faculty had a variety of opportunities to improve their facility with computers. During the Spring term, several introductory courses in computing were provided for the faculty. Some of these were taught by colleagues and some by staff hired for that purpose. During the Summer, faculty could receive grants to visit other universities in order to gather ideas for using computers in their classes. Time, money, and consultants became available for members of the faculty who wished to develop their computing skills or to work on revising their courses in ways which would involve computing. Among the 105 Assistant Professors, 71.4% availed themselves of the training opportunities to increase their knowledge of computing. Among the 111 Full Professors in the study, 56.8% applied for at least one of the benefits available through the training program, and among the 94 Associate Professors, 60.1% applied.

If perceived effects on status influenced attitudes toward the computer decision, differences in response to opportunities to prepare for the change should be related to rank and attitude toward computing, after controlling for effects of prior competence. That is, members of the faculty who had previously believed computing to be important might have acquired a sufficient amount of knowledge to be comfortable with a new

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computing requirement and need no further training. By hypothesis, whether members of the faculty without experience in using computers would attempt to gain experience would depend on their ranks and their attitudes toward the new policy requiring students to own computers.

Log-linear analysis (SAS, 1982) of the relationship of rank, computer-competence, and attitude toward the new computer requirement supports the hypothesis (see Table 2).

At the rank of Full Professor, attitude toward the computing policy seemed to have a much larger impact on participation in the training projects than did computer-competence. At the rank of Assistant Professor, however, attitude toward the computing policy had no effect on participation in training projects. Among those who neither had prior experience with computing nor were pleased by the decision to require computers, the lower the rank, the more likely to take advantage of opportunities to learn.

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Table 2

Computing Competence, Decision Satisfaction & Training*
(% Who Took Advantage of Training Opportunities)

Professorial Rank	Not Computer-Competent		Computer-Competent	
	Not Pleased	Pleased	Not Pleased	Pleased
Full	(N=16) 37.5	(N=32) 81.3	(N=18) 22.2	(N=45) 60.0
Associate	(N=25) 52.0	(N=27) 77.8	(N= 8) 75.0	(N=34) 50.0
Assistant	(N=10) 100.0	(N=36) 75.0	(N=21) 61.9	(N=38) 65.8

SOURCE	DF	CHI-SQUARE	PROB.
Intercept	1	13.10	.0003
Rank	2	8.17	.0168
Competence	1	5.40	.0201
Response	1	0.85	.3563
Rank*Competence	2	2.30	.3172
Rank*Response	1	10.96	.0042
Competence*Response	1	0.06	.8070
Rank*Competence*Response	2	5.26	.0719

*Academic faculty only

The questionnaire listed fifteen ways that people could use computers, asking respondents to note whether they had considerable experience, a little experience, or no experience with each. Prior to training, computers had most commonly been used to handle numeric computations. (Considerable experience was reported by 48%.) The faculty was almost as

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likely to have read printouts showing results of empirical studies (reported by 44%). Writing software in a high level language (reported by 28%) ranked third, and using computers as word processors ranked fourth (reported by 27%). Statistically reliable differences among different faculties appeared for most of the uses.

Giving equal weight to each use, a score for computer experience was assigned to a person by summing the number of times that a person reported having considerable experience. Scores ranged from 0 to 15. Regression, using curriculum as a dummy variable, showed that differences represented by curriculum accounted for about 11% of the variance, $F(3, 306)=12.12$, $p<.0001$. The Duncan (1975) multiple-range test, with alpha at .05, showed that the means for natural scientists (M=3.8), engineers (M=3.7), and faculty in the College of Business (M=3.0) did not differ significantly; faculties in these three colleges had significantly more experience using computers than had those in the liberal arts (M=1.6).

A stepwise procedure (SAS, 1982) was used to identify models that would account for variance in computing experience within curricula. Using .15 as the significance level to enter and to stay, the procedure identified a best-fitting model by selecting appropriate variables from a list that included age, length of employment at Drexel, rank, score on a scale measuring pleasure in teaching, score on a scale measuring satisfaction with Drexel and its facilities, and responses to questions asking about teaching and prior education.

Among faculty teaching in the College of Business, age was the single best predictor for experience using computers, accounting for 18.6% of the variance in types of experience, $F(1, 53)=12.15$, $p<.0010$. In addition to relative youth, those who had more experience with computers among the faculty in the College of Business were less likely than their colleagues to have taken academic courses since receiving their highest degrees, more likely than colleagues to have studied formal logic, more likely to have taken a course in statistics or accounting, and were more likely to know

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how to read music. Together, the model based on these variables accounted for 40.1% of the variance in the scale measuring computing experience, $F(5, 49)=6.56$, $p<.0001$.

In the engineering college as well as in the business college, younger faculty were likely to have more computing experience, $F(1,71)=26.30$, $p<.0001$, accounting for 22.4% of the variance. In contrast with the business school faculty, however, engineers who used computers most were more likely than their colleagues to have taken academic courses after receiving their highest degrees. In addition, among engineers, those with more computing experience were more likely than their colleagues to teach courses requiring repetitive problem solving by students. The model based on age, having taken academic courses since acquiring a degree, and teaching courses in which repetitive work was required of students accounted for 33.7% of the variance among engineers' use of computers, $F(3, 69)=11.69$, $p<.0001$.

In the College of Science, the best predictor for amount of experience was age, $F(1, 72)=10.73$, $p<.0017$, accounting for 12.0% of the variance. Having taken courses in drafting, design, painting or sculpture and knowing how to read music also contributed to the model predicting computing experience. This model accounted for 19.9% of the variance in amount of computing experience among the science faculty, $F(3, 70)=5.78$, $p<.0015$.

Among faculty in the liberal arts, having taken a quantitative course (statistics or accounting) was the most important predictor of computing experience, predicting 23.1% of the variance, $F(1, 95)=28.57$, $p<.0001$. In addition, computing experience was related to recency of employment at Drexel and having a higher rank. The model based on date of first employment at Drexel, rank, teaching courses with repetitious exercises, and having taken courses in logic, statistics, or accounting controlled 41.1% of the variance in the scale measuring computing experience, $F(5, 91)=12.67$, $p<.0001$.

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Summary and Discussion

Rapid increase in the availability of inexpensive computers raises questions about the social impact likely to result. As part of an attempt to understand that impact, evidence from the beginning of a longitudinal study of change at an urban university has been analyzed. The data were collected shortly after announcement that incoming freshmen of the following year would be required to buy microcomputers. Members of the faculty were asked about their experience with computers, their attitudes toward the decision, their educational histories, and their teaching styles.

The data showed that faculty attitudes toward the decision were dependent upon interaction between rank and computer-competence. Faculty with the rank of Full Professor, regardless of their own computer-competence, tended to have a favorable attitude toward the decision. If they viewed the decision favorably and were not already computer-competent, these members of the faculty participated in some form of training. Faculty with the rank of Assistant Professor also tended to view the technological conversion favorable; their participation in training, however, appeared not to be influenced by their attitudes toward the decision. In the middle rank, that of Associate Professor, faculty who were computer-competent were more pleased than those above or below them in rank; on the other hand, Assistant Professors who were not computer-competent were less pleased than those above or below them in rank.

The interaction between academic rank and both decision satisfaction and participation in training projects suggests that computer-competence, may have begun to erode traditional grounds for status acquisition. It seems reasonable to expect changes in teaching styles that will reflect an increasing emphasis on informal authority among those who do not acquire facility with computers. This informal authority would be based on increased personal contacts between faculty and students.

Profiles of faculty who were most knowledgeable about computers suggest important differences based on academic discipline. Except in liberal arts, younger faculty were most likely to have used computers. For engineers, knowledge of computing seemed tied with their continuing

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education. Among natural scientists, computing seemed more closely allied with having varied interests (in music and the visual arts). Among faculty in liberal arts, those who had acquired knowledge of computing had been exposed to technical courses (statistics, accounting, formal logic). Faculty in the College of Business were more likely to be computer-competent if they had broad interests, combining technical backgrounds in statistics, accounting, and logic with ability to read music, and if they resisted the professional development seminars now common in the business world. These profiles suggest that technological explorers had previously been mavericks in their field.

Although this report depicts only the beginning of a shift in the academic environment, the evidence suggests that there could be important changes in the authority structure of the university as a result of the proliferation of computing.

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